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Hydrogeochemistry of Springs Water and Groundwater from Southwestern Region of Nigeria

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Abstract

The purpose of this paper is to present the physical and chemical constituents of springs water and groundwater from some parts of crystalline rocks of Southwestern region of Nigeria to ascertain the degree of their potability. Samples were collected from twenty locations in the study area. Heavy metals such as Ba^{2+}, Ca^{2+}, Cr^{6+}, Zn^{2+}, $\sum Fe$, Cu^{2+} and Pb^{2+} were analyzed using Atomic Absorption spectrophotometer, Calcium, magnesium, sulphate, bicarbonate and chloride were determined by wet analysis while sodium and potassium were determined by flame photometry. Values of the total dissolved solid (TDS) ranged from 121.2 to 152.2 mg/l and 153.5 to 195.5 mg/l for groundwater and spring water respectively. Heavy metal concentration in spring water was in order of $Zn^{2+} > Cu^{2+} > Cr^{6+} > Cd^{2+} > Ba^{2+} > Fe \approx Pb^{2+}$ and in groundwater from the same region was $Zn^{2+} > Cu^{2+} > Cr^{2+} > Pb^{2+} > Ba^{2+} \approx Fe > Cd^{2+}$. Quality of water samples from springs and groundwater from the study area may be classified as good based on the hydrogeochemistry. The results the analyses shows that the heavy metals and major ions satisfied the World Health Organization drinking limits except in few samples were Cu^{2+}were above the limits. The higher occurrence of Cu^{2+}in few samples were mild but may create problem for health due to bioaccumulation (causing free radical charge), therefore such water should be treated or discarded.

Keywords: Radiometric health hazards, Heavy metals, Hydrogeochemistry, Pollution, Water quality.

Introduction

The two main problems human beings are facing related to water are the quality and quantity of water supplied for drinking and other purposes. A clean and safe supply of water is necessary to ensure a high quality of life and strong economy. In the Basement Complex of Southwestern Nigeria, spring water and groundwater are the alternative sources to surface water, since surface water is easily polluted. Groundwater and spring water are regarded as being

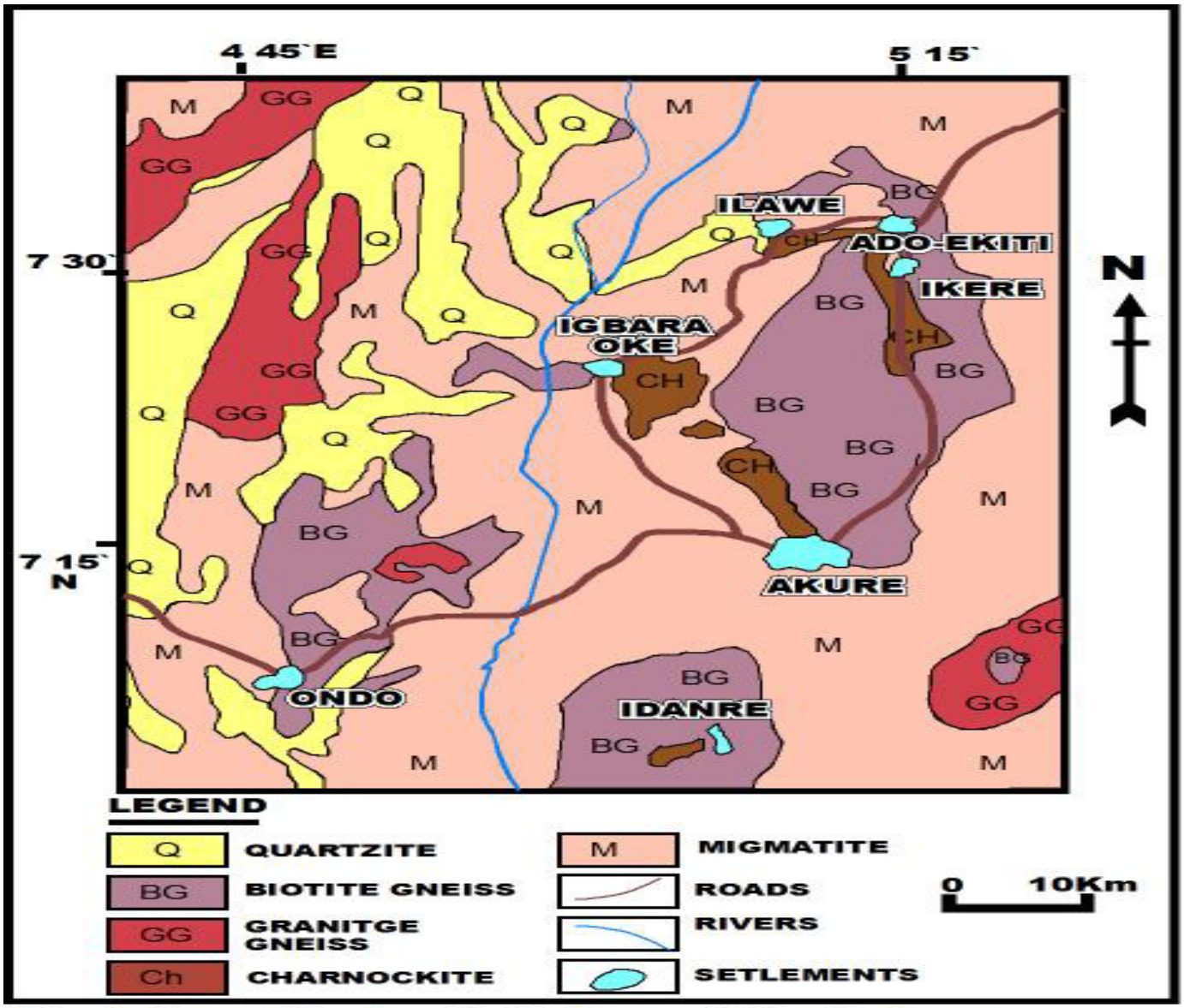

Fig. 1. Generalized geological map of the study area (Southwestern Nigeria).

protected from contamination when compared to surface water but can be rendered unusable due to anthropogenic factors (Obiefuna and Orazulike, 2011, Boboye, 2008, Olobaniyi, et al. 2007, Akoet al. 1990).The term heavy metal refers to any metallic element that has a relative high density and is toxic or poisonous at low concentration. The concentrations of heavy metals in natural waters have been of considerable interest because some heavy metal are extremely dangerous to human health when ingested at doses higher than drinking water standard. Sometimes, springs waters and groundwater may be polluted by heavy metals. Continuous exposures to heavy metal contaminants through drinking water are responsible for various ailments including cardiovascular disease, dermatitis, reproductive failure, allergies and some cancers. Many heavy metals such as ∑Fe, Mn^{2+}, Ni^{2+}, Zn^{2}+, Cu^{2+}, Cd^{6+} and Pb^{2+} occur in nature in ore deposits (Aiyesanmi, 2006).

The purpose of this paper is to determine the level of some heavy metals in selected spring's waters from some groundwater in parts of Basement Complex of Southwestern region of Nigeria. The results of this investigation will provide information on the concentrations, distribution and health effects of heavy metals in natural waters in the Basement Complex of Southwestern Nigeria. The study area is situated in Southwestern Nigeria, which cover parts of Ondo, Akure and Igbara – Oke in Ondo State, as well as Ikere and Ilawe in Ekiti State. This study area lies between latitudes $7^{o}\ 05^{1}$ and $7^{o}\ 45^{1}$ North of Equator and longitude $4^{o}\ 35^{1}$ and $5^{o}\ 20^{1}$ East of Greenwich Meridian (Figure 1). The study areas have a tropical climate of wet and dry seasons, which is characterized by high annual rainfall of over 1800mm. Wet season start from April and end in October while the dry season is from November to March. The vegetation is dense evergreen forest of tall trees with thick undergrowth. Two major drainage patterns were observed; these are dendritic and trellis patterns.

General Geology of the Study Area

The study areas fall within the Pre – Cambrian crystalline rocks of Southwestern Nigeria (Rahaman, 1976, Rahaman 1988). Five dominant rock type types have been recognized in the study area, they are Biotite – gneiss, granite – gneiss, quartzite, charnockite and migmatites (Figure 1).

Water samples collected from the region are from biotite - gneiss and charnockite except in Ondo town were water samples collected are from biotite -gneiss only. From the results of the analysis, it was observed that the concentrations of heavy metals are higher in water samples from Ondo than the water samples from other part of the study area. It is possible that the major source of the heavy metals is due to water rock interaction. Biotite gneisss may be their major source, since their concentration is within the drinking water standard except in few water samples were copper concentration exceed its limit.

Materials and Methods

Twenty samples from springs, boreholes and hand dug wells were collected from five towns namely Ondo, Akure, Igbara – Oke,Ikere and Ilawe – Ekiti in southwestern Nigeria. Samples were collected in plastic bottles to avoid any contamination. Samples were taken to the laboratory Chemistry Department, Federal University of Technology Akure for analysis. Heavy metals such as barium, zinc, chromium, lead, copper, cadmium and iron were analyzed with Atomic absorption spectrophotometer using standard methods established by APHA 1998 for metals determination and details are contained in Ogunribido, (2000). Physical parameters that were measured in the field were pH, temperature, TDS, conductivity and turbidity using hand held water quality analyzer, sodium and potassium by flame photometry method while calcium, magnesium, bicarbonate, chloride and sulphate by titrimetric method.

Results and Discussion

The results of the laboratory analyses of the heavy metals from springs water and groundwater is shown in Table 1 while Table 2 shows the heavy metals range, mean concentration and WHO 1998 standard.

The pH values for groundwater range between 6.3 and 7.3, and for the spring water it range between 6.5 and 7.1 and these values, however fall within the WHO 1998 drinking water standard of range of 4.5 to 8.5. The highest TDS was 199.5 mg/l and was measured in the spring water at Ilawe, this indicates that there was more time for water to interact with the host rock making more dissolution of the minerals. The concentrations Cr^{2+}, Zn^{2+} and Cu^{2+}were relatively high generally greater than 1.6mg/l while levels of other heavy metal are generally low, that is lower than

Table 1. Concentration of heavy metals in water samples (mg/l).

Site	Sample No	Ba^{2+}	∑Fe	Zn^{2+}	Pb^{2+}	Cr^{6+}	Cu^{2+}	Cd^{2+}
Ikere	S1	0.27	0.13	3.14	0.26	1.22	1.37	0.39
	G1	0.21	0.22	4.11	0.21	1.51	3.12	0.32
	S2	0.22	0.33	3.31	0.17	1.61	2.34	0.28
	G2	0.24	0.14	3.52	0.18	1.18	1.89	0.32
Ilawe	S3	0.21	0.25	2.25	0.26	1.82	3.22	0.21
	G3	0.25	0.12	3.23	0.25	1.25	1.48	0.33
	S4	0.24	0.35	2.92	0.31	1.14	2.24	0.29
	G4	0.28	0.24	3.14	0.22	1.31	1.38	0.11
Igrara-Oke	S5	0.32	0.27	3.15	0.13	2.13	3.13	0.31
	G5	0.29	0.28	3.33	0.16	1.52	2.25	0.32
	S6	0.24	0.24	3.52	0.28	1.34	2.82	0.31
	G6	0.21	0.25	4.13	1.31	2.23	3.32	0.11
FUTA(Akure)	S7	0.18	0.25	3.32	0.23	1.43	2.15	0.21
Oshinle(Akure)	G7	0.16	0.25	3.81	0.24	2.31	2.52	0.11
	S8	0.31	0.26	3.15	0.31	1.63	3.24	0.32
	G8	0.28	0.33	4.23	0.24	1.25	3.13	0.11
Ondo	S9	0.31	0.27	2.82	0.28	2.14	2.37	0.22
	G9	0.32	0.35	4.31	0.53	1.76	1.38	0.21
	S10	0.25	0.33	3.72	0.31	2.22	2.17	0.32
	G10	0.31	0.35	3.51	0.32	2.31	1.29	0.31

Table 2. Heavy metals, range, mean concentration and WHO 1998 and USEPA 2009.

Heavy metals	Overall range (mg/l)	Gw range (mg/l)	Spring water range (mg/l)	Spring Mean (mg/l)	GW mean (mg/l)	Accepted level (mg/l) WHO 1998	USEPA values (MCL) 2009
Ba^{2+}	0.16 – 0.32	0.16 – 0.32	0.18 – 0.32	0.25	0.24	0.70	2.00
Cd^{2+}	0.11 – 0.39	0.11 – 0.33	0.13 – 0.39	0.26	0.22	5	5
Cr^{6+}	1.14 – 2.31	1.18 – 2.31	1.14 – 2.22	1.68	1.75	5.0	0.10
Zn^{2+}	2.25 – 4.23	3.14 – 4.31	2.25 – 4.23	3.24	3.72	5.0	2.00
∑Fe	0.12 – 0.35	0.12 – 0.35	0.13 – 0.35	0.24	0.24	0.3	0.30
Cu^{2+}	1.29 – 3.32	1.29 – 3.32	1.37 – 3.24	2.31	2.31	2.0	1.0
Pb^{2+}	0.13 – 0.53	0.13 – 0.53	0.16 – 0.31	0.24	0.33	0.5	0.015

0.3mg/l. In all the spring water and groundwater samples analyzed, the mean concentrations of all the elements for which WHO limits exist except Cd^{2+}, Cr^{6+} and Cu^{2+} were below the recommended values. There were no violations of the limits for the elements Ba^{2+}, Zn^{2+} and Pb^{2+} in any of the samples. In any uncontaminated spring water and groundwater in the study area, the source of Ba^{2+}, Zn^{2+}, ∑Fe and Pb^{2+} may be due to the weathering of various mineral of the host geologic formation of the spring water and groundwater. The mean concentrations of Ba^{2+}, Zn^{2+}, ∑Fe and Pb^{2+} are 0.26, 3.24, 0.24 and 0.24mg/l respectively (Figures 2 and 3). Cadmium is a toxic metal with a long history of detrimental effects. High cadmium levels severely irritate the stomach, leading to vomiting, bone damage and fragile bones. Ingesting very large amounts of chromium can cause stomach upsets, ulcers, convulsions, kidney and liver damage even death. Long term exposure to copper can cause irritation of the nose, mouth and eyes and it also causes headaches, stomach aches, dizziness, vomiting and diarrhea. High uptakes of copper may cause kidney damage and even death. Since Cu^{2+} in both the spring water and groundwater in the study area are above WHO drinking water standard in some samples there is likely that the consumers may be affected by the above mentioned health hazards after a long term ingestion. A comparison between heavy metal concentrations in spring water and groundwater

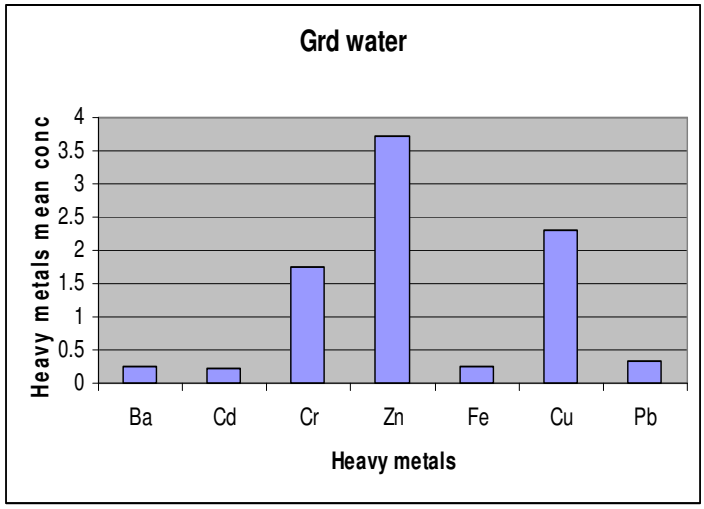

Figure 2. Bar charts of heavy metal mean concentration in Groundwater.

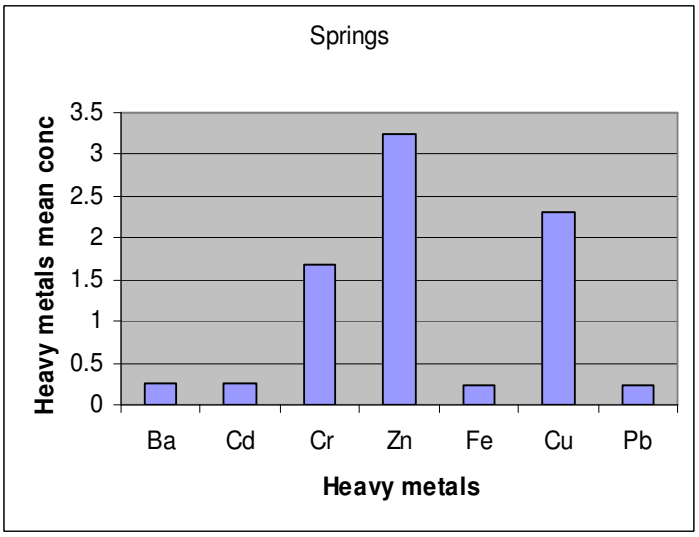

Figure 3. Bar charts of heavy metal mean concentration in springs.

samples shows that spring water generally has higher concentrations of elements such as Pb^{2+}, Cr^{6+}, Cu^{2+} and Cd^{2+}. The concentration of the major ions of spring and groundwater samples were plotted on piper's tri linear diagrams as shown in Figures 4 and 5 respectively. The plot of chemical data on diamond shaped tri linear diagram revealed that the majority of the spring and groundwater samples fall in the Na Cl and K HCO_3^- facies

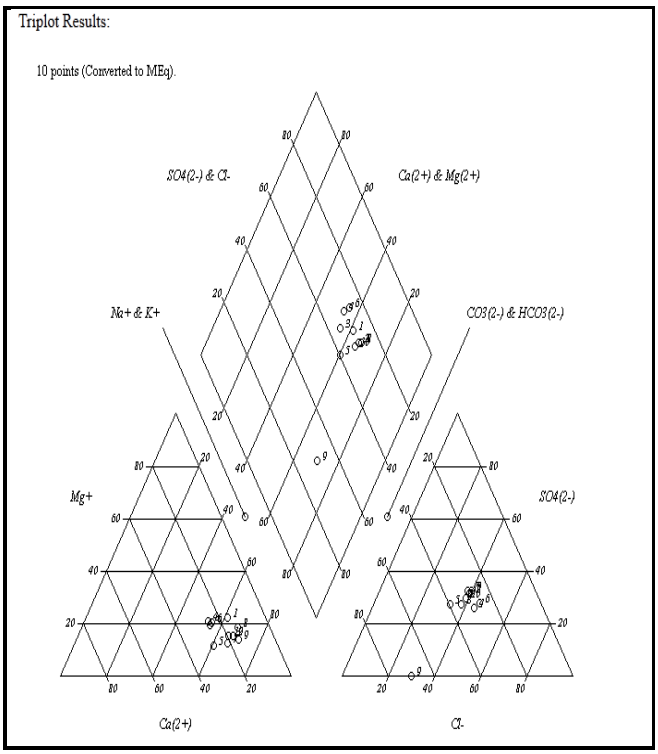

Figure 4. Spring water pipers diagram.

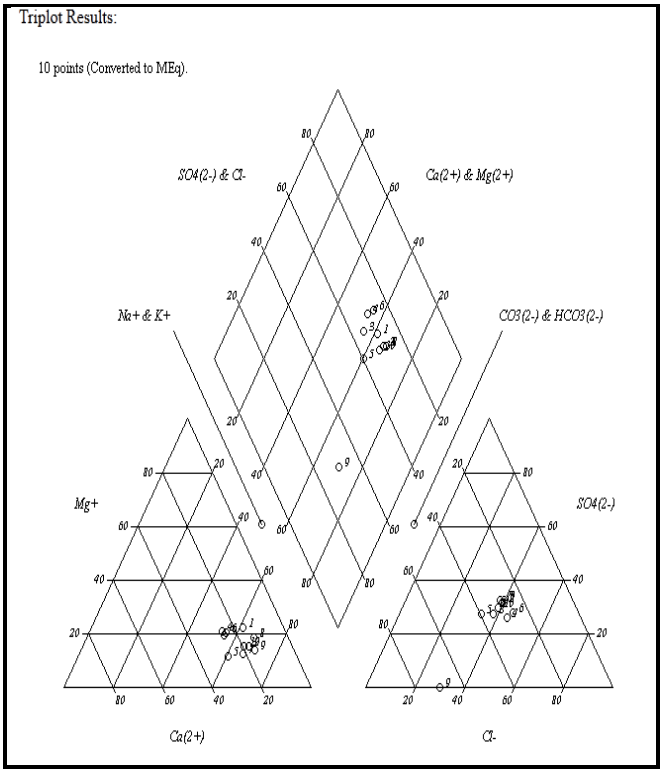

Figure 5. Groundwater piper's diagram.

Conclusion

This paper has presented data on the concentrations of some heavy metals such as Ba^{2+}, Cd^{2+}, Cr^{6+}, Zn^{2+},$\sum$Fe, Cu^{2+} and Pb^{2+} and major ions which include; sodium (Na^{+}), potassium (K^{+}), calcium (Ca^{2+}), magnesium (Mg^{2+}), chloride (Cl^{-}), bicarbonate (HCO^{3-}), sulfate (SO_4^{2-}) and nitrate (NO_3^{-}), as well as silica (SiO_2), electrical conductivity (Ec), and pH in both spring water and groundwater samples from parts of Southwestern Nigeria. Heavy metals present in both the spring water and groundwater in the study areas are within the drinking water standard except in few cases where copper exceed its limits, therefore water in the study areas are good for domestic purposes except where copper exceed its limits. The violation of Cu^{2+} was mild but may cause taste or constitute health hazards due to bioaccumulation.

References

Aiyesanmi, A.F. 2006. Baseline concentration of heavy metals in water samples from Rivers within Okitipupa Southeast belt of the Nigerian bitumen. Journal of Chemical Society of Nigeria, 31(1&2), 30 – 37.

Ako, B.D., Adeniyi F.I and Adepoku J.F, 1990. Statistical tests and chemical quality of shallow groundwater from a metamorphic terrain, Ile-Ife/ Modakeke S.W Nigeria. Journal of Earth Science, 10 (4), 603-613.

APHA, 1998. Standard methods for the examination of water and wastewater, APHA, New York.

Asubiojo, O.I., Nkono, N.A., Ogunsua A.O., Oluwole A.F., Ward N .I., Akanle, O.A., Spyrou, N. M. 1997. Trace elements in drinking and groundwater samples in southern Nigeria. The Science of Total Environment, 208, 1-8.

Boboye, O.A. 2008. Hydrogeochemical assessment of groundwater in Iddo area, Southwestern Nigeria, Journal of Mining and Geology, 4 (2), 183-201.

Ogunribido, T. H, 2000. Geochemical characteristics of Spring waters in parts of Southwestern Nigeria, Unpublished Master of Technology Thesis, Federal University of Technology Akure, pp.70.

Obiefuna, G.I and Orazulike, D.M. 2010. Assessment of groundwater quality of Yolaarea for Irrigation purposes. Water Resources Journal of Nigerian Association of Hydro geologists, 20(1), 32 – 52.

Olobaniyi, S.B., Ogala J.E. and Nfor N.B. 2007. Hydro geochemical and bacteriological Investigation of groundwater in Agbor area, Southern Nigeria. Journal of Mining and Geology, 43(1), 79 – 83.

Rahaman, M.A. 1976. Review of the basement geology of Southwestern Nigeria. In C A Kogbe (ed) Geology of Nigeria, Elizabethan publishing company, Lagos, 41 – 58.

Rahaman, M.A. 1988. Benin – Nigeria Geo-traverse, International Meeting on Proterozoic Geology and Tectonic of High – Grade Terrains, Program and Lecture Series Project 215, 1 – 36.

USEPA 2009. Groundwater sampling and monitoring with direct push technologies, USEPA, Washington, DC.

World Health Organization. 1998. Guidelines for drinking water quality recommendations.

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